INTEGRATED WASTE MINIMIZATION TECHNIQUES IN APPAREL DESIGN: A SUSTAINABLE PERSPECTIVE

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INTEGRATED WASTE MINIMIZATION TECHNIQUES IN APPAREL DESIGN: A SUSTAINABLE PERSPECTIVE

1.0 INTRODUCTION

Design future is concerned with humanity, and more specifically, how a design can contribute to the continuation of humanity. As Fry, T. (2008) reported that design is intrinsically linked and intertwined with humankind and the myriad problems facing the current state of the world.

The Indian textile and apparel industry is one of the largest and oldest sectors in the country and is primarily concerned with the design and production of yarn, cloth, clothing, and their distribution. Clothing, manufactured from textile, is a very important part of our life both in function and for fashion. UNEP (2007) reported that with the population growing gradually and economy booming in the world, the need of textile products accordingly has increased rapidly, which results in the immense generation of textile and apparel waste due to over-production and over-consumption. However, the problem of textiles waste is not new to the industry. The disposal behavior of these wastes affects the environment, socially and economically. As Bartl (2011) stated that besides increasing pollution, manufacturing process of textile products needs a lot of energy. Thus, for the purpose of reducing wastes, waste prevention or waste management is the best option for saving environment.As Mass DEP (2013) reported that the prevention of waste from textile and apparel can return ideal revenue from economic, social and environmental aspects.

Designing appropriate textile waste management techniques play an important role in minimizing the production of wastes and its disposal into landfills and incinerators. In today's scenario with global focus on sustainability, extending a fashionable product's life beyond the recognised horizon will certainly have a positive impact to which the designer and consumer can play a key role.

1.1 Overview of the Indian Textile and Apparel industry

The Indian Textile and Apparel industry is one of the largest and oldest sectors in the country and among the most important in the economy in terms of output, investment and employment.

Its supply chain is diverse and complex, spanning four or more tiers, including design, raw material harvesting, spinning, yarn production, dyeing, weaving, cutting, stitching and final garment construction.

The potential size of the Indian textiles and apparel industry is expected to reach US$ 223 billion by 2021 and exports of textiles and clothing at US$ 64.41 billion by the end of March, 2017. A strong raw material production base, a vast pool of skilled and unskilled personnel, cheap labor, good export potentials are some of the salient features of the Indian textile and apparel industry.

Some other significant features of Indian textiles and apparel industry have been stated below:

- The Indian textiles industry accounts for 14% of industrial production, which is 4% of GDP.
- It employs 45 million people and accounts for 12% share of the country's total exports basket.
- In 2013, India became second largest exporter of textile & garment in the world surpassing Italy and Germany.
- India exported textile and garment goods worth US$ 40 billion, with a share of approximately 10% of global textile and garment trade. The Indian exports are increasing at a CAGR of 16% since 2009.
- Boon (2012) investigated that there are around 30,000 garment manufacturing companies in India producing just for export. Out of this 5,000 companies are well established in the sense of performance and stability.

India's growing population has been a key driver of textile consumption growth in the country. The increase in young population complemented with an increasing female workforce has resulted in changing of tastes, preferences and fashion. Clothing is more related to trends and personal style; hence people tend to purchase clothing more frequently than household textile products. The 'National Household Survey 2008 released by The Textiles Committee, Ministry of Textiles, reveals that Indians purchase 22.41 meters of textiles in a year. While the demand for sarees continued unabated, the dhoti market has reduced by 8.59%, selling 11.7 crore pieces. Interestingly, jeans are bought more in the rural areas. (as per 2009 report 'National Household Survey 2009 released by The Textiles Committee, Ministry of Textiles). Wallander

(2012) stated in his study that global data reveals that more than two billion t-shirts and 124 million denim jeans are sold every year.

Thus, the processes of accelerated population growth and continued high levels of consumption translate into a greater volume of textile and apparel waste being generated. As a result, worldwide pressures on the environment issues are steadily increasing.

1.2 Waste generation from Textile and Apparel Industries

Waste has been defined as any product or substance that has no further use or value for the person or organization that owns it, and which is, or will be, discarded. However, what may be discarded by one party may have value to another. Thus, the definition for 'waste' should be redefined to consider this waste as a potential reusable resource for others. The amount of waste generated, and its actual or potential negative effects on the environment, are matters of concern to government, industry and the community. Waste is perceived to be a problem for many reasons, but the three reasons most often cited are that: waste disposal can harm the environment and human health; space for landfills is claimed to be becoming scarce as industries strive for zero waste targets; costs are increasing to use existing and replace landfills. Waste is the end of apparel lifecycle that causes costly environmental impacts and depletes valuable resources and energy intensive processing and production processes of apparel manufacturing. (Refer fig 1.1)

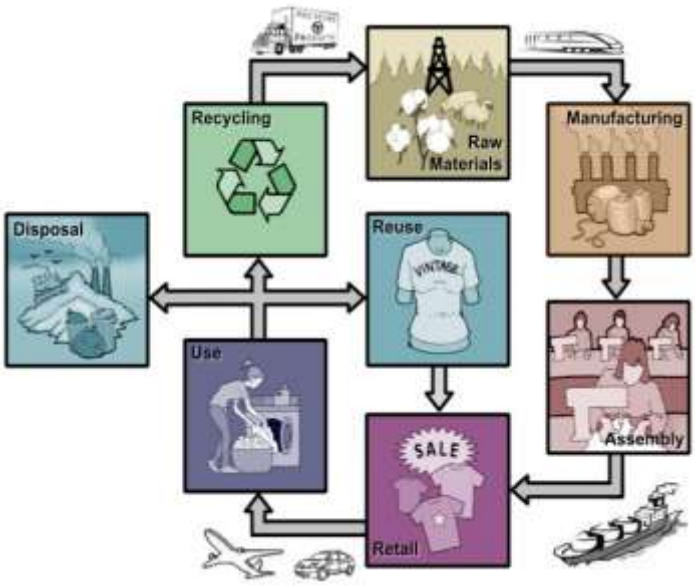


Figure1.1 Life cycle of a Garment
https://oroeco.wordpress.com

The industrial large-scale fashion production has material wastage rates ranging from 5 to 20 percent. When fiber was limited and textile processes were time consuming (e.g. hand-spinning and weaving) fabric was valued and expensive. Rissanen, (2007) reported that material was cut as little as possible and clothing was designed in order to

avoid waste during cutting. As Rissanen (2008) reported that current garment production using conventional fashion design and pattern-cutting techniques which results that approximately 15 percent fabric waste, it can vary between 10 and 20 percent depending on the garment design. As Niinimäki (2013) stated in his study that in small studio scale production, the rate of waste can even reach 50 percent. Worldwide production volume in the clothing industry is vast, as a result of which a massive amount of textile material gets wasted. The textile and clothing industry has been challenged by environmental concerns at all levels of the manufacturing of clothing.

The waste is generated largely at the marker planning and making and at the cutting stages. Rissanen (2008) reported that traditional garment production using cut-and-sew techniques yields approximately 15 % fabric waste; the estimate varies between 10–20 % depending on the garment style. Therefore, there is a need to eliminate the fabric waste not only at textile production and process but also at the stages of designing, pattern cutting and sewing. In the fashion industry, the current practices are unsustainable. As reported by Rissanen (2007) contemporary fashion design and production has faced criticism for the wasteful way in which fabric is cut compared with, for example, the way fabric is used in traditional dress forms.

In addition, Katkar & Bairgadar (2010) stated consumers react to changes in fashion. Seasonal changes in fashion mean that clothes can become outdated very quickly, and this encourages the replacement and disposal of outdated, yet good quality garments. Hawley (2008) reported that this results in issues of over consumption and disposal of unused clothes leading to burdening of the resources throughout the world. This presents a double-edged sword, in that while at the same time it stimulates the economy, it also gives rise to the increased problem of apparel and textile disposal. Joseph (2001) reported that piles of unfashionable, unsuitable clothing, not yet worn out but no longer wearable are further wasted. Rissanen, (2013)stated that as a result of production and manufacturing clothes or after consumption that 73% of clothes are thrown away end up in landfills for that fast fashion movement is accused as not sustainable habit.

Joung & Park-Poaps, (2013) reported that in this manner, overall apparel industry contributes to both pre-consumer and post-consumer textile waste.

1.3 Textile and Apparel waste

Textile waste can be divided into two broad categories: Pre-consumer textile wastes and post-consumer textile wastes. (Refer fig: 1.2)

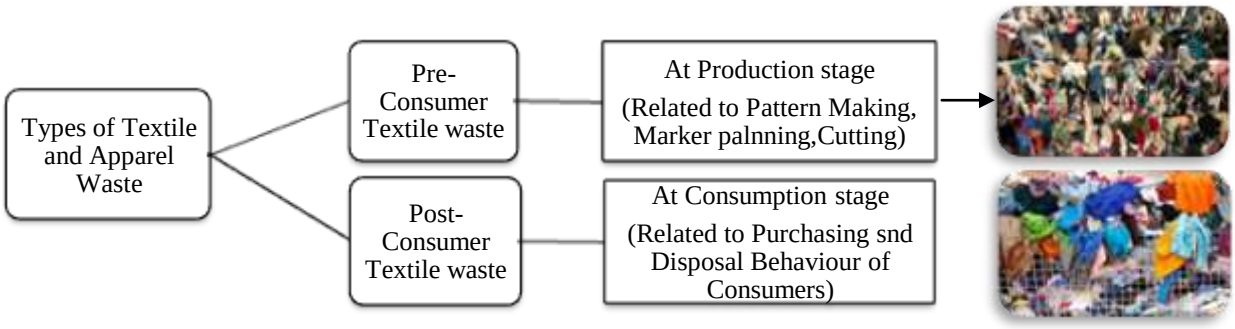

Types of Textile and Apparel Waste
Pre-Consumer Textile waste
Post-Consumer Textile waste
At Production stage
(Related to Pattern Making, Marker palnning,Cutting)
At Consumption stage
(Related to Purchasing snd Disposal Behaviour of Consumers)

Figure 1.2 The process of waste generation

1.3.1 Pre-consumer textile wastes refer to the left-over materials generated during the manufacturing process in textile, fibre and cotton industries (Chavan, 2014). Pre-consumer textile waste takes place at the stage of production level. Pre-consumer textile waste is usually "clean waste".

1.3.2 Post-consumer textile wastes refer to the unwanted apparel or other household products, which are made from the manufactured textiles, for the consumers and households. As Chavan, (2014) reported that his waste is usually generated after the textiles have been consumed and discarded by the consumers

When comparing the two categories of textile wastes, post-consumer textile wastes are a much more serious and difficult problem than the pre-consumer textile wastes. As Chavan, (2014) stated in his study that due to the better cooperation among the textile industries, pre-consumer textile wastes produced during the manufacturing process can be recycled as raw materials for paper, furniture stuffing, mattress, etc. However for post-consumer textile wastes, as they are related to the purchasing and disposal behavior of different households, it is much more difficult to monitor and initiate collaboration in reducing textile wastes. (CTR, 2015) reported that in US, around 75% of the pre-consumer textile wastes can be diverted from the landfills and recycled, while only 15% of post-consumer textile wastes are recycled But in India

the situation seems to quite gloomy, since manufacturers and consumers are comparatively less aware of the hazards related to environmental degradation.

1.4 Solutions to minimize Textile and Apparel waste

The way in which the fashion industry uses fabric to make garments is arguably wasteful and unproductive. For the garment manufacturer, garment costs money to make and this cost is a sum of numerous parts. Usually the two most significant sources of garment cost are fabric and labour for construction (usually sewing). As Cooklin, (2007) reported that fabric makes up around 50 percent of the cost price of a garment and labor 20 percent. It is therefore in the manufacturer's economic interest to be able to make each garment from as little fabric as possible without compromising the fashion designer's intent regarding garment appearance or fit.

The three R's are commonly used terms in waste management; they stand for "reduce, reuse, and recycle". As waste generation rates have risen, processing costs increased, and available landfill space decreased, the three R`s have become a central tenet in sustainable waste management efforts. As El-Haggar et al., (2007) reported that there is a high degree of consensus amongst researchers working in the field of waste management that there is a clear hierarchy amongst the approaches that might be adopted to the management of waste within the fashion industry.

1.4.1 Waste hierarchy model

The waste hierarchy ranks waste management options according to the best environmental outcomes taking into consideration the lifecycle of the material. The lifecycle of a material is an environmental assessment of all the stages of a product's life from-cradle-to-grave.

Figure 1.3 Waste hierarchy model (www.letsrecycle.com)

1.4.1.1 The steps of waste hierarchy

i. Prevention-

Prevention is the most preferably step in the waste hierarchy, (European commission, 2012) argued that waste prevention focuses on improving the producing procedure and to prevent waste from occurring in the manufacturing process of textiles and clothing.

Figure 1.4 Recycling logo (http://sukirgenk.dyndns.berlin)

ii. Reuse-

This is the second step in waste hierarchy, after lowering the amount of waste from production. When people do not want their garments they can keep them, throw in the garbage, sell them or give them away.

iii. Recycling

Rijkman and Rockstorm (2012) suggested that generally the recycling rates are very low. Because recycling is not economically beneficial and technologically limited that's why there are not many companies that work with recycling of textile fibers. Even though, the method of collecting textile waste for recycle has existed in the market previously.

iv. Disposal-

It is the last step and the worst situation in the waste hierarchy. According to Palm (2011) disposal is the most common way of treating textile waste after charity submission. Disposal involves mostly energy recovery through incineration, in this process the disposal textiles are burned and produce energy.

Thus, the waste hierarchy gives top priority to preventing waste and least priority to disposal. When waste is created, it gives priority to preparing it for reuse, then recycling, then other recovery, and last of all disposal.

In addition to the above mentioned general techniques of waste management there are two specific techniques in the field of textiles and fashion which have been receiving considerable mention in the recent literature, namely; **Zero waste management techniques** and **Up-cycling.** These two novel techniques could prove to be beneficial for waste utilization at pre and post consumer levels respectively.

1.5 Zero waste fashion design

Rissanen, (2013) reported that zero waste fashion design (ZWFD) is a method of pattern making that particularly aims to eliminate fabric waste from garment production. In its larger sense, the concept of zero waste fashion refers to a fashion system where waste is eliminated through all stages of garment design, production chain and the use phase.

It is based on age-old practices of using a piece of fabric so that none is wasted, and it has recently been highlighted as a useful tool for sustainability in fashion design. According to Rissanen (2005), the Himation, Chiton and Peplon of ancient Greece, the Indian sari, and Japanese kimono are traditional garments constructed using the entire fabric.

Figure 1.5 Chiton, Saree and Kimono; some examples of zero waste garments

In ZWFD, the processes of patternmaking and design are integrated, instead of being separate. The simultaneous process of patternmaking and fashion design enables the complete usage of the fabric: design decisions can be made during an evolving process of patternmaking, guided by the aim of zero fabric waste.

1.5.1 Techniques for the process of zero waste fashion design

The ZWF design methods are categorized into two groups according to their design process frames based on (Rissanen, 2010) and **(**Rissanen, 2013) -

i) Conventional fashion design process - The conventional fashion design approach starts with sketching or draping to make a decision on the garment's final design, and then moves on to patternmaking.

ii) Reversed fashion design process –The reversed fashion design approach begins its process with an abstract idea or a sketch or draping and finalizes its design through pattern designing. It does not start with a fixed design. Five Zero waste fashion methods were positioned under these two categories. Knitting and Layer method belongs to the former group,

when Minimal cutting, Jigsaw puzzle, and Subtraction cutting fall under the latter. Some of these methods are as follows: (Refer table no: 1(a) and (b)

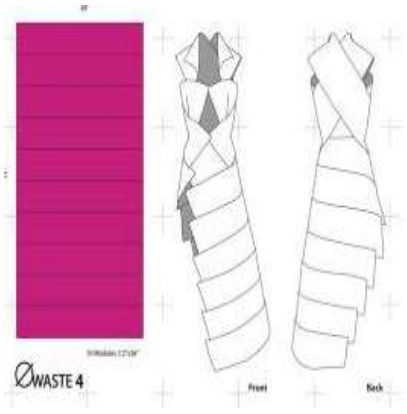
Types of zero waste fashion design	Description	Illustrations
Conventional fashion design		
a) Knitting method	Knitting method is subdivided into two methods: Pattern piece knitting and Seamless knitting. Knitting method, especially domestic hand knitting is one of the most common ZWF design methods (Rissanen, 2013). Pattern piece knitting is knitting individual garment pieces and sewing them together (Black, 2002). (Refer fig: 1.6)	 Figure 1.6 Designs by Wollford (2000)
b) Layer method	In this method fabric is cut into lines (layers) and by adding these layers, a surface is formed. It employs the basic principle of line, surface, and figure. Fabric is cut into lines and by adding these layers, a surface is formed. When these surfaces come together, a figure is made. This figure can be a garment or a part of a garment. By adding layers, nothing is subtracted and no waste is generated. (Refer fig: 1.7)	 Figure1.7 Designs by Holly Macquilion

Table no: 1(a) Zero waste fashion design techniques under Conventional fashion design process

2. Reversed fashion design process.

a) Minimal cutting method	Minimal cutting designs garments through draping and minimizes the number of cuttings. It consists of two design methods: No cut and Minimal cut. In both methods, the number of pattern is always one. No cut method designs without any cutting as in traditional costumes, similar to the Indian sari. The shape of the garment is designed through draping and it depends on the width and length of the fabric as shown in figure (Carrico and Kima, 2014). (Refer fig: 1.8)	 Figure 1.8 Designs by Madeleine Vionnet (1919) from Kirki(1998) and Demornex(1991)
b) Jigsaw puzzle method	Jigsaw puzzle method designs patterns to interlock perfectly on fabric, and leaves no waste. It can be applied to either flat pattern or draping. Rectangular, Square or triangular shaped patterns and patterns with curved, complex lines appear frequently in traditional zero waste garment designs as Jigsaw puzzles (Rissanen, 2013; McQuillan, 2009; Niinimäki, 2013; Townsend and Mills 2013). (Refer fig: 1.9)	 Figure 1.9 Designs by Mark Liu (2007)

c) Subtraction cutting method	According to Roberts (2013), Subtraction cutting its basic technique is called the tunnel technique. The whole fabric is folded in half and sewn together to form a tunnel. Holes and space are created where the body passes through. This technique can be used anywhere, in pants, skirts, or sleeves. However, it can consume more fabric but is creative way to approach fashion design and can be considered as an alternative method of designing clothes. (Refer fig: 1.10)	Figure 1.10 Designs by Julian

Table no: 1(b) Zero waste fashion design techniques under Reverse fashion design process

1.6 Up-cycling: a solution to post consumer textile waste

Up-cycling is a process where waste or useless products are transformed into new materials or products of equal or better quality or a higher environmental value. It is taking waste and maintaining or improving the quality of it by making something new. As Smusiak (2010) investigated that the goal of up-cycling is to prevent the wasting of potentially useful materials by making use of existing ones.

Figure 1.11Up-cycling logo (http://carryon.be/)

As Murray (2002), suggested up-cycling textiles is not merely conserving the resources that went into the production of a particular material, but by adding the value embodied in them by the application of knowledge in the course of their recirculation.

The Up-cycling process involves four stages as illustrated in figure:

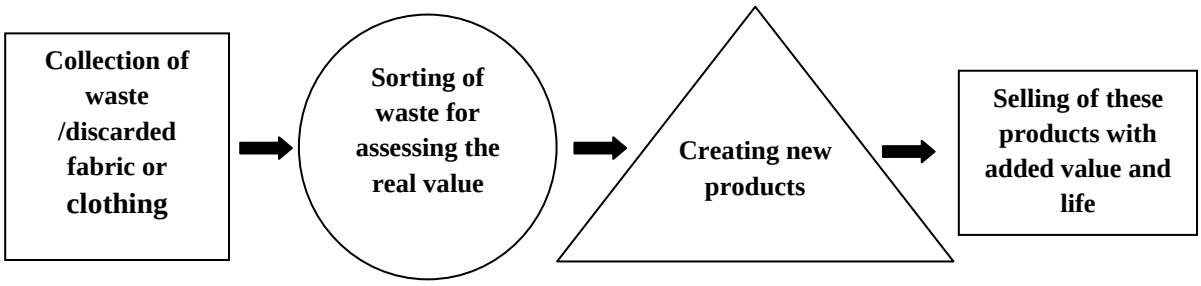

Collection of waste /discarded fabric or clothing
Sorting of waste for assessing the real value
Creating new products
Selling of these products with added value and life

Figure 1.12 Process of Up-cycling

As a sustainable strategy for design, up-cycling provides a designer with the opportunity to reassess the real worth and value of a waste material through the design and manufacturing of new products. As Allison, Gwilt and Timo Rissanen, (2012) investigated that rather than recycling, which can result in the downgrading of a material up-cycling seeks to further prolong the life and value of a product and material.

The process of up-cycling is more than just use old and raw material. By this kind of re-use the raw material is augmented into an object of higher status than the original object. It is about upgrading used material and making it more desirable than it was at the start. As reported by Zero Waste International Alliance, 2010; by allowing the largest possible amount of textile waste to be given new value, up-cycling can solve the problems associated with fashion textile waste and could be an incremental step towards achieving zero waste.

1.7 Need for the study

Today, fashion is one of the most dynamic, challenging and fastest growing sectors and therefore, it influences environmental, economic and social system in many ways. Today's fashion design practice has been criticized for its unnecessary and uneconomical consumption of resources, which is the main cause of rapid increase in textile waste. The sustainability movement is all pervasive today and touches many elements of consumer's daily lives. Making fashion sustainable means taking into account more than just style, quality and cost. Not only production has moved mass-market but the way consumers consume clothing has changed a lot over the past 20-30 years too. The recent idea of "seasonal new collection" and "fast fashion" in

apparel industry has been one noteworthy reason for enhancement in production and increasing clothing consumption volumes.

A century ago, consumer spent more than half our money on food and clothes, today consumers spend less than a fifth, as fast fashion items are made in extremely efficient production systems with low quality, which leads to low end prices. As Niinimäki (2011) reported that low prices lead to an increase in consumption volumes; moreover, low quality leads to a shortening of the lifetime of clothing items). Currently, when the value of the fabric is low, industrial large-scale fashion production has material wastage rates ranging from 5 to 20 percent. Accordingly more pre-consumer textile waste is created.

The need for effective apparel waste management is motivated by the increasing cost and decreasing availability of landfill space and the dwindling of natural resources. Claudio, (2007) reported that post-consumer, textiles are often resold by primary consumer to other consumers at lower price, exporting in bulk for sale in other countries or recycling back to raw material for manufacture of apparel and non apparel products or given away in charity but in India, options available include handing on treasured pieces to family members, recycling within the home, giving to servants, bartering them for new stainless steel pots or burning them for their silver and gold content.

Textiles are nearly 100% recyclable so, in the textile and apparel industry nothing should be wasted. It is vital to address the source of the problem by maximizing the use of textile materials and by minimizing the wastage at production and consumption stages. Various designing techniques could be incorporated at pattern making and designing stage so that the wastage is controlled at the point of inception. Whereas, for minimizing the post-consumption wastage, the process of up-cycling could be the best option. N.G.O.'s like Goonj**,** in India also collect post-consumer textiles to recycle clothes, and provide basic amenities to people living in villages in different parts of the country depending on the need of the community.

If textile waste can be prevented, it can solve both waste disposal and resource waste problems at the same time. It is essential to address the source of the problem by minimizing the wastage and by maximizing the use of textile materials. Therefore to decrease the consumption

of textile, and ultimately, the environmental pollution, there is an urgent demand to minimize wastage of fabric that reduces its effects on environment.

1.8 Justification of the study

The vast amount of textiles waste within the fashion industry has resulted in committed research within the emerging field and has been an area of focus for fashion researchers to design techniques of minimizing the textile waste, to make environment pollution free. Due to the rapidly increasing production, purchase and disposal of fashion objects, consumers are putting a strain on natural and human resources at unprecedented levels. Braungart & McDonough, (2002) suggested that with most products designed with a traditional cradle-to-grave life-cycle in mind the environmental consequence of increasing waste streams has become an important issue of the twenty-first century. (Ekström and Salomonson, 2014) suggested that both clothing and textile reuse and recycling, are under-researched areas and that more information is needed on how reuse and recycling can be utilized by different stakeholders in society. Consequently, a new movement, zero-waste fashion, has sprung up. Zero-waste garments are produced with little or no textile waste.

Gay (2011), argued in his study that by preventing waste from being generated in the first place contributes to principle of economy in design, fabric and execution**.** Although recently popularized as a response to fast fashion, zero-waste design has been around for centuries. It can be found in many traditional garments, like the Japanese kimono and the Indian sari. Design elements often included gussets or gores, minimal arm shaping, rectangular sleeves or pants, and people engineered garment pieces to match the available fabric's length and width. Rissanen (2013) also suggested that by reducing the number of seams used in the construction of garment could enable faster garment manufacturing potentially reducing energy consumption and labour. Khar & Ayachit (2013) revealed that Zero waste garments had very few seams and were made with little or no material wastage from the cutting. Rissanen (2008) reported that current garment production using conventional fashion design and pattern-cutting techniques results in approximately 15 percent fabric waste, which can vary between 10 and 20 percent depending on the garment design

Existing waste minimisation strategies focus on exploring the original cradle-to-grave garment life-cycle. As McQuillan, Rissanen, and Roberts, Rissanen (2013) reported that recent literature review explores a potentially endless life-cycle through textiles reuse known as a 'cradle-to-cradle' approach with strategies such as zero-waste cutting aim to prevent the waste of textiles in the production phase of the garment lifecycle. Secondly, Gwilt (2012) Finn and Fraser, 2014aiming to extend the original garment life-cycle through the provision of reliable garment services draw on a 'mend and make do' approach. As Fletcher (2008), and Fraser, (2009) reported that interventions that aim to divert textiles from landfill at the end of the garment life-cycle include strategies such as up-cycle, re-make and re-use. In other words, through adopting minimization as a design strategy, in fashion and textiles industries, waste can be eliminated at the design stage of any outfit thus generating more sustainable practices within the industries. This implies that the designer must understand the waste minimization processes, involved in the construction of the garments at their designing stage.

With the importance of sustainability growing by and large across apparel manufacturers and the textile industry, the concept of zero waste design, needs to progress from individual designers to mass markets. It needs to be commercialized to change the way textiles are being used and to build positive environmental results. At present there are many approaches and techniques of zero waste design which include draping, pattern cutting, and knitting and moreover there are many designers who have ventured into the art of creating garments with minimal waste. Experts of zero waste design believe that the cut and sew production of all kinds will diminish in the next thirty years to come. Zandra Rhodes, Holly McQuillan, Tara St. James, Julian Roberts, Timo Rissanen, and Mark Liu are some designers who have changed the periphery of fashion with an innovative approach to zero waste design. Some Indian fashion designers as Karishma Shahani, Ruchika Sachdeva, Shalabh and Anita Ahuja, Agrima Batra, Jaspal kalra, Bhumika and Jyoti, and Siddhartha Upadhyaya are also working on the concept of zero waste fashion design in India, to counteract the wasteful practices of Indian textile and apparel manufacturing sector.

India being the hub of apparel production generates tons of fabric waste which negatively impacts the environment. This research study has been planned to design and create apparels

with little or no textile waste. It also intends to evolve various techniques to up-cycle the produced apparel waste. The literature review illustrates that the designers working in the field of zero waste fashion designing have mostly fashioned western wear designs and styles. This study was planned to create contemporary Indian women wear using different waste minimization practices. Keeping in the mind the above facts, a problem was formulated with objectives stated below-

INTEGRATED WASTE MINIMIZATION TECHNIQUES IN APPAREL DESIGN: A SUSTAINABLE PERSPECTIVE

1.9 Objectives of the study

1. To explore the current textile waste disposal and recycling practices of the apparel industry
2. To identify the different stages and sources of textile waste generation at various stages of garment production.
3. To design contemporary Indian women wear by incorporating selected techniques of zero waste fashion design through CAD.
4. To up cycle the post-consumer textiles waste by creating potential apparel products.
5. To disseminate the information regarding the adopted waste minimization techniques to existing apparel and textile units, or new start-ups.

1.10 Operational definitions:

- **Integrated**

  According to Merriam-Webster integration is ‘‘to combine two or more things to form or something.’’

- **Perspective**

  According to Cambridge dictionary, “Perspective is a particular way of considering something.’’

- **Sustainable**

According to Merriam-Webster sustainability is, “involving methods that do not completely use up or destroy natural resources.”

- **Up-cycle**

  Up-cycling is the practice of creating a useable product from waste or unwanted items or adapting an existing product in some way to add value. The purpose of up-cycling is reducing waste and improving the efficiency of resource use. (http://whatis.techtarget.com/definition/upcycling)

- **Zero waste fashion design**

  Zero Waste fashion design is about constructing garments with minimum wasting fabric, usually making good use of a single piece of fabric.

- **Waste**

  Waste is, “A situation in which something valuable is not being used or is being used in a way that is not appropriate or effective”

1.11 Delimitations of the study

- The present study will be limited to a sample of 20 Apparel manufacturing industries of Uttar Pradesh only.
- In this study, only selected zero waste fashion design methods will be used for designing of women wear.
- Only contemporary Indian women wear will be designed in this study.

Apart from these, there are some other delimitations with reference to the dissemination of information of the waste minimizing techniques designed during the course of study could be stated as follows:

- As, Zero waste is a new concept for buyer and manufacturer, it will take a lot of time and effort to accept it. The concept of zero waste fashion designing will need a change in the supply chain of the fashion industry, hence may lead to increased cost. The literature review states that zero waste requires heavy involvement primarily from industry. Connett & Sheehan (2001) also suggested that zero waste will not be possible without significant efforts and actions from industry and government.

As, a result, it may be difficult to induce buyer and manufacturer to adopt zero waste fashion designing with immediate effect but sincere efforts would be made by the researcher to generate awareness to adopt zero waste fashion designing through various modes of promotion.

2.0 Review of literature

Review is the process of reading, analyzing, evaluating, and summarizing scholarly materials about a specific topic. A literature review is a text, written by researchers to consider the critical points of current knowledge including substantive findings, as well as theoretical and methodological contribution to a particular topic. Thus for the present study, the available literature is compiled on the basis of a range of variables, included in this study such as environmental impact of textile waste, zero waste fashion design, pre-consumer zero waste fashion design, post-consumer zero waste fashion design, re-using of old and discarded clothing, up-cycling of clothing and other sustainability techniques.

Some of variables of the study are elaborated below:

2.1 Environmental impact of apparel wastes

Due to the rapidly increasing production, purchase and disposal of fashion objects consumers are putting a strain on natural and human resources at unprecedented levels which is harming to environment. Braungart & McDonough (2002) investigated that with most products designed with a traditional cradle-to-grave life-cycle in mind, the environmental consequence of increasing waste streams has become an important issue of the twenty-first century.

Monika Holgar (2009) also revealed that technology's move towards increasing miniaturization and sensitivity, the demand for increased performance in clothing and textiles, and the growing global eco consciousness suggest great promise in this area for further research and development. As (Hawley 2006**)** reported that recovering textiles for reuse or recycling contributes significantly to the environmental and social responsibility of textile and apparel industries.

(Schor 2011) also suggested that no consumer product is more closely representative of the velocity of which fashion objects can be become obsolete than clothing. Although clothing is not the most ecologically significant consumer item, it is on the front line of unsustainable consumer practices.

2.2 Waste management

Waste is directly linked to the human development, both technologically and socially. Waste management is a distinct practice from resource recovery which focuses on delaying the rate of consumption of natural resources. Lo et al.,(2013) studied the impact of environmental management systems in textile industries and stated that "the production of textile and related products often requires high levels of energy & water consumption and emits large quantities of pollutants to the environment. Therefore, the adoption of environmental management systems is important and could have a significant impact on firms' operational performance.

Reducing the waste generated is important because, as (Ericson 2010) estimates, 'The garment industry is responsible for 7 per cent of world carbon emissions'. The three R's are commonly used terms in waste management; they stand for "reduce, reuse, and recycle". As waste generation rates have risen, processing costs increased, and available landfill space decreased, the three R`s have become a central tenet in sustainable waste management efforts (El-Haggar, 2007; Seadon, 2006; Suttibak & Nitivattananon, 2008; Tudor et al., 2011).

2.3 Sustainable designs for clothing

The concept of sustainable fashion design decreases the waste of textile and demand of natural sources. (Nam 2010) investigated that sustainable design is a design concept that takes environment, economy, and society into consideration. It embraces overall environment concerned designs including eco-friendly design, but also adds the notion of responsibility. Dickson M. et al., (2012) also suggested that Sustainable fashion is not a trend; it is way of designing the styles as per positive future demands. Moon et al., (2013) also reported that on the basis of concept of sustainability, sustainable fashion represents a fashion product design that

maximizes its positive impact and minimizes its negative impact on society, economy, and environment. Nam (2010) argued in his study that as fashion products consume a large proportion of the world's resources and pose a threat to the environment with toxic chemicals, textile waste, energy loss, and retail, sustainable fashion is becoming more and more important. Furthermore, (Kim 2008) stated that sustainable designs can be obtained by the six different methods listed below: using organic fabric or new material, order-made, reform, reuse, recycle, and designing multi-functional products.

2.4 Zero waste fashion design

Zero Waste fashion designing is a method of patternmaking that particularly aims to eliminate fabric waste from garment production. It is based on age-old practices of using a piece of fabric so that none is wasted, and it has recently been highlighted as a useful tool for sustainability in fashion design. RCBC (2002) reported that s number of companies have successfully embraced the zero waste concept including Hewlett-Packard, Kimberly Clark, and The Body Shop.

Zero waste fashion is products or clothing that generates little or no textile waste in their production. Spiegelman (2006) also suggested that zero waste refers to waste management and planning approaches which emphasize waste prevention as opposed to end of pipe waste management According to the report of (Snow & Dickinson 2001); Townend (2010), the zero waste philosophy has been adopted as a guiding principle by several governmental organizations as well as industries.

Young et al., (2010) discussed in his study that zero waste encompasses more than eliminating waste through recycling and reuse; it focuses on restructuring production and distribution systems to reduce waste. Snow & Dickinson (2001) reported that even if it is not possible to completely eliminate waste due to physical constraints or prohibitive costs, zero waste provides guiding principles for continually working towards eliminating wastes. Townend (2010) also argued that there are many successful cases around the world which resulted from the implementation of the zero waste philosophy.

The focus of zero waste is on eliminating waste from the outset, it requires heavy involvement primarily from industry and government since they are presented with many

advantages over individual citizens. Connett & Sheehan (2001) also suggested that zero waste will not be possible without significant efforts and actions from industry and government. Spiegelman (2006) reported that due to the heavy involvement of industry in eliminating waste, extended producer responsibility is often an essential component of zero waste strategies.

Zero waste fashion design can also be combined with the other traditional textiles for creating new and innovative clothing, as Wafa Abd Elradi in his study (2015) explored the Zero-waste techniques in designing and producing women clothes that express Egyptian identity through inspiring Nubian motives and applying macrame technique.

The opportunity to eliminate fabric waste from garment production lies within the stages of pattern-making and fashion design. More precisely, in order to realize zero fabric waste garments, pattern-making must be considered as an integral part of the design process. That is, one aims at creating interlocking pattern pieces on a two-dimensional surface, which can then be transformed into a three-dimensional garment Rissanen, (2008). As discussed by McQuillan (2011) and Rissanen (2008), there are numerous ways to approach the aim of zero fabric waste. The zero waste patternmaking process mostly begins with some basic guidelines such as the type of garment and the width of the fabric.

2.5 Pre-consumer zero waste fashion design

Pre-consumer Zero waste fashion design reduces textile wastes produced from manufacturing of any apparel or garment. (Rissanen 2008) in his study found that with 10-20% of textiles used in apparel production landing on the cutting room floor, there is a significant opportunity to turn around this impact. Because of this textile waste environment pollution takes place. Joung & Park-Poaps (2013) also investigated that the overall apparel industry contributes to both pre-consumer and post-consumer textile waste, so it is necessary to avoid apparel waste at its pre stage. It is also easy to agree with the idea of pre-consumer zero waste fashion design, that it is better to avoid waste than to fill the planet with things made from it Rissanen (2005).

2.6 Post-consumer zero waste fashion design

As Hawley (2008) reported that post-consumer waste is defined as any type of garment or household article made from manufactured textiles that the owner no longer needs and decides to discard.

Ekström & Salomonson (2014) also argued that reuse is the preferred method for waste reduction by consumers. Solomon & Rabolt (2009) also found in his study that when considering options for disposing of post-consumer apparel and textile waste, consumers have several options: discard, donate, reuse, trade or sell. They also suggested that both clothing and textile reuse and recycling, are under-researched areas and that more information is needed on how reuse and recycling can be utilized by different stakeholders in society. According to (Mitra 2000) reusing the materials can also help the poor countries to minimize the cost of treating the wastes.

Darrel (2007) in his study argued that through the efforts of textile industry, approximately 75 per cent of the pre- consumer textile waste that is generated, is diverted from landfills instead recycled. Recycling or reuse of pre consumer textile waste is necessary to save environment. Many industries and organizations are running to reduce and reuse of fabric.

Briga-Sá et al., (2013) investigated the potential of reusing textile wastes. They illustrated that textile wastes are an enormous source of secondary raw material that is not used, but can be re-injected into the market.

2.7 Up-cycling

Up-cycling refers to reuse of a garment where its quality remains the same or is increased by the process, attempting to counter the common problem of recycling practices reducing the quality of the original materials. It has been increasingly recognized as a promising means to reduce material and energy use. ‘‘Up-cycling confers an environmental benefit by reducing, or at least delaying, the addition of trash to our landfills.’’ (Anderson, Holland & Hart 2009).

(Gwilt & Rissanen 2011) suggested that up-cycling is taking waste material from a state as close to the original as possible to avoid dramatic reprocessing and making products that are of better quality or have greater environmental value. Smusiak (2010) also reported that the goal of up-cycling is to prevent the wasting of potentially useful materials by making use of existing ones.

Supporters of the environmentally friendly practice of up-cycling claim that developing countries have been up-cycling for years, re-using packaging and old clothing in new ways, although more concerned about their own need than the environment. Zero Waste International Alliance (2010) reported that up-cycling is an incremental step towards achieving zero waste. Now up-cycling is taking off in developed countries as well, reflecting an increase in interest for eco-friendly products. Braungart & McDonough (2002) suggested that up-cycling is, as long as there is an abundance of waste. As stated by (Fletcher, 2008) Reusing, repairing and reconditioning garments are some of the most sustainable choices. Murray (2002), in the book Zero Waste explains that up-cycling textiles is not merely conserving the resources that went into the production of a particular materials, but by adding the value embodied in them by the application of knowledge in the course of their recirculation.

2.8 Fast fashion

A fast fashion system is a combination of quick response production with enhanced product design capabilities to both designs that capture the latest consumer trends and exploit minimal production lead times to match supply with uncertain demand. Fast fashion is a clothing production strategy that emphasizes moving high-end catwalk trends into stores in the shortest amount of time possible at the cheapest possible price point. It was introduced in 1980s and ’90s by brands like Zara and Benetton, Forever21 and H&M.

Fast fashion refers to the clothing’s which are low cost and imitate the present luxuriousness fashion trends. Annamma et al.,(2012), revealed that it reflects the desire of young people which symbolizes instability. Claudio (2007) reported that globalization has made it possible to produce clothing at increasingly lower prices, prices so low that many consumers consider this clothing to be disposable some call it „ fast fashion“, the clothing equivalent of fast food.

According to Siegle (2011) fast fashion firms meet the demand of consumers with low prices and new weekly product offerings, which quickly fall apart or become out-dated, pushing quantity demand up while pulling prices down. Katkar & Bairgadar (2010) investigated that seasonal changes in fashion mean that clothes can become outdated very quickly, and this encourages the replacement and disposal of outdated, yet good quality garments. This results in

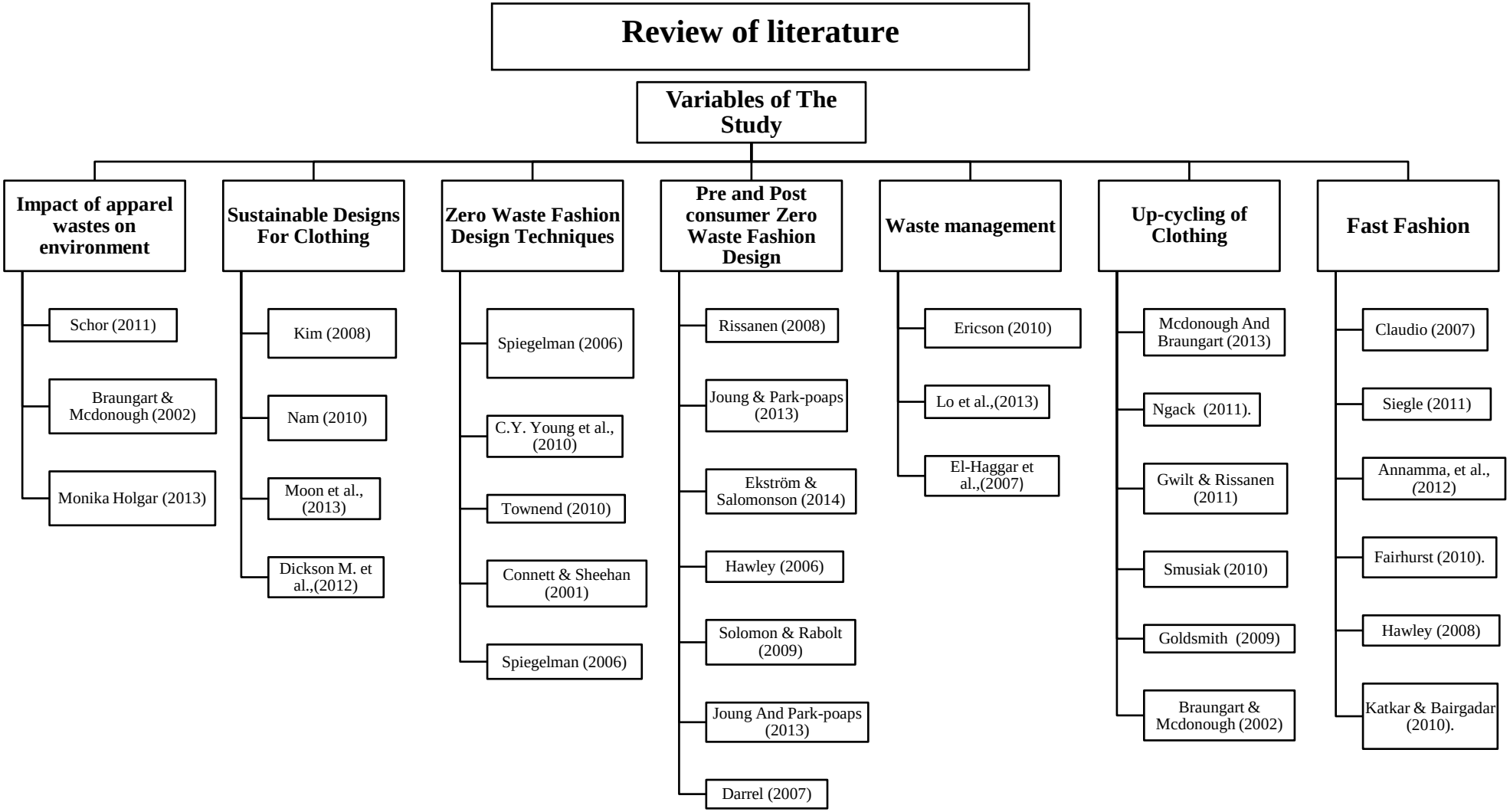
issues of over consumption and disposal of unused clothes leading to burdening of the resources throughout the world as stated by (Hawley 2008) resulting in post consumer waste.

The literature review matrix is shown as in Table no. 2.

		Content																	Research approach				
		Impact of apparel wastes		Sustainable designs For Clothing			Zero Waste Fashion Design		Pre and post-consumer Zero Waste Fashion Design		Waste management			Up-cycling Of Clothing			Fast Fashion							
S. No.	Researcher	Consumer	Effect	Awareness	Benefits	Approach	Pioneering designs	Benefits	Innovative designs	Consumer awareness	Waste recovery	Disposal	Potential	Value	Acceptance	Awareness	Impact on	Sustainability	Consumer behavior	Descriptive	Survey	Empirical	Exploratory	Case study
1.	Sophie Scamans																✓				✓			
2.	April Shannon McGrath																	✓			✓			
3.	Tina Yinyin Wang																		✓			✓		
4.	Gary Davidson										✓									✓				
5.	Hazel Clark				✓																	✓		
6.	Jennifer wang													✓						✓				
7.	Judith Neukam						✓																	✓
8.	Kirsten Schaefer & Henry Navarro								✓													✓		
9	Gail Jeanne Myers														✓						✓			
10.	Holly McQuillan						✓																✓	
11.	Jay caldarine						✓																✓	
12.	Hye-Shin Kim	✓																			✓			
13.	Gunter Pauli													✓									✓	
14.	Reet Aus		✓																			✓		
15.	Kyungeun Sung													✓						✓				
16.	Ina Hjelte							✓															✓	
17.	Rebecka Thorstensson															✓						✓		

		Content																		Research approach				
		Impact of apparel wastes			Sustainable designs For Clothing		Zero Waste Fashion Design		Pre and post-consumer Zero Waste Fashion Design		Waste management			Up-cycling Of Clothing			Fast Fashion							
S. No.	Researcher	Consumer attitude	Effect	Awareness	Benefits	Approach	Pioneering designs	Benefits	Innovative designs	Consumer awareness	Waste recovery	Disposal behavior	Potential barriers	value	Acceptance	Awareness	Impact on environment	Sustainability	Consumer behavior	Descriptive	Survey	Empirical	Exploratory	Case study
18.	S. Cuc		✓																	✓				
19.	Şule Altun			✓																	✓			
20.	Sonja Jordeva,												✓								✓			
21.	Bahareh zamani					✓																		✓
22.	Evrim Buyukaslan					✓														✓				
23.	Autumn S. Newell										✓													✓
24.	Lee Tsz Kwan Esther										✓										✓			
25.	Bairagi N								✓													✓		
26.	Jana M. Hawley											✓											✓	
27.	Kerryn Caulfield	✓																			✓			
28.	Varsha Gupta & Ajit Khare															✓						✓		
29.	Timo Rissanen						✓															✓		
30.	Serap tanrisever								✓													✓		
31.	Kirsi Niinimäki						✓																	✓
32.	Jaspal Kalra								✓													✓		

		Content																	Research approach				
		Impact of apparel wastes			Sustainable designs For Clothing		Zero Waste Fashion Design		Pre and post-consumer Zero Waste Fashion Design		Waste management			Up-cycling Of Clothing			Fast Fashion							
S. No.	**Researcher**	**Consumer attitude**	**Effect**	**Awareness**	**Benefits**	**Techniques**	**Pioneering designs**	**Benefits**	**Innovative designs**	**Consumer awareness**	**Waste recovery**	**Disposal behavior**	**Potential barriers**	**value**	**Acceptance**	**Awareness**	**Impact on environment**	**Sustainability**	**Consumer behavior**	**Descriptive**	**Survey**	**Experimental**	**Exploratory**	**Case study**
33.	Anyango Yvette Anne-Marie															✓					✓			
34.	Darshita Modi													✓								✓		
35.	Chege Ivy Nyaguthii											✓											✓	
36.	Sinwon Cho						✓															✓		
37.	Kirsi Niinimäki					✓																	✓	
38.	Fiona Mary Cribben			✓																		✓		
39.	Farhana Ferdousi			✓																	✓			
40.	Atiq Uz Zaman							✓												✓				
41.	S. Kavitha												✓								✓			
42.	Alice Ruth Payne				✓																		✓	
43.	Carrico & Victoria Kim						✓															✓		
44.	Bin Shen					✓															✓			
45.	Gary Davidson											✓											✓	
46.	Dalia M. M. Yacout										✓													✓


Review of literature
Variables of The Study
Impact of apparel wastes on environment
Schor (2011)
Braungart & Mcdonough (2002)
Monika Holgar (2013)
Sustainable Designs For Clothing
Kim (2008)
Nam (2010)
Moon et al., (2013)
Dickson M. et al.,(2012)
Zero Waste Fashion Design Techniques
Spiegelman (2006)
C.Y. Young et al., (2010)
Townend (2010)
Connett & Sheehan (2001)
Spiegelman (2006)
Pre and Post consumer Zero Waste Fashion Design
Rissanen (2008)
Joung & Park-poaps (2013)
Ekström & Salomonson (2014)
Hawley (2006)
Solomon & Rabolt (2009)
Joung And Park-poaps (2013)
Darrel (2007)
Waste management
Ericson (2010)
Lo et al.,(2013)
El-Haggar et al.,(2007)
Up-cycling of Clothing
Mcdonough And Braungart (2013)
Ngack (2011).
Gwilt & Rissanen (2011)
Smusiak (2010)
Goldsmith (2009)
Braungart & Mcdonough (2002)
Fast Fashion
Claudio (2007)
Siegle (2011)
Annamma, et al., (2012)
Fairhurst (2010).
Hawley (2008)
Katkar & Bairgadar (2010).

3.0 Research methodology

Methodology is a systematic and logical analysis to the research problem. It is a science of studying problem to carry out scientific solutions. For any research, plan of action needs to be formulated as a blue print which is known as research design. As Liehr & Smith (2003) reported that the investigator understands plans and explores the best practice which may be appropriate to the specific problem. This chapter will highlight the procedure that will be followed by investigator to achieve the objectives of the research.

The present study will be an exploratory cum experimental study. Pattern making will be the main tool of the present study. In this study, waste minimization techniques will be explored and adopted to create a range of apparels and accessories for women. Several methods would be experimented with, to reduce, reuse and up-cycle the apparel and textile waste. The study will be accomplished under four phases which are elaborated below:

3.1 Phase I

Exploratory phase

3.2 Phase II

Experimental phase

3.3 Phase III

Evaluation phase

3.4 Phase IV

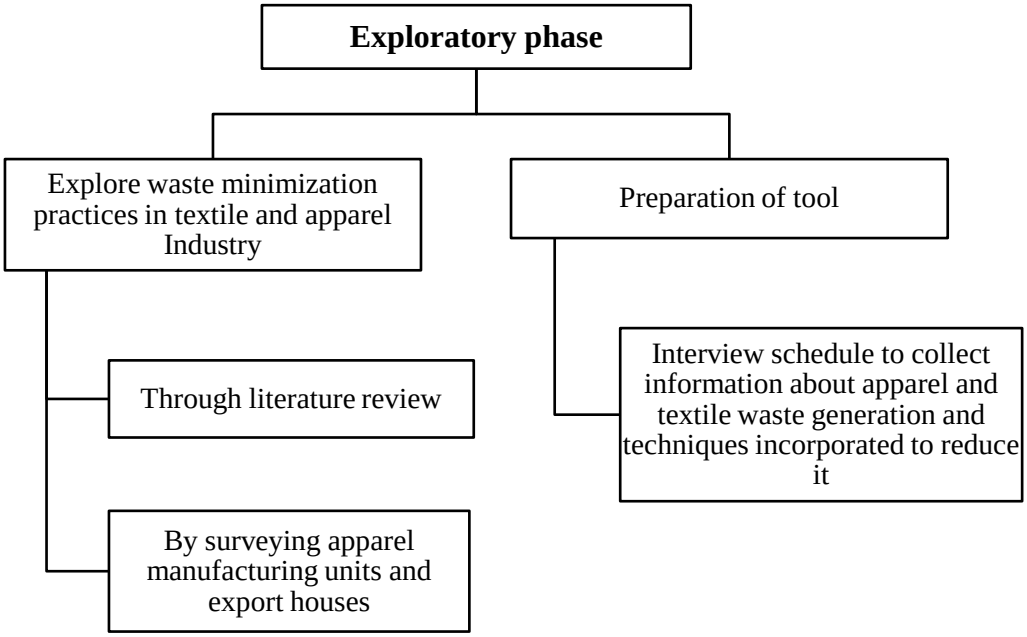
Dissemination of information

3.1 Phase I - Exploratory Phase:

The present research is planned to achieve the objective of minimization of fabric waste at various stages of production. Therefore, the first attempt will be to collect data and information regarding the quantity and quality and stages of waste generation from Textile and Apparel Industries. This would carried out by exploring 20 Apparel manufacturing industries/ Export Houses situated in Uttar Pradesh (Mainly in NCR, Kanpur, Allahabad, Lucknow and Agra regions).

To collect the initial information related to the statement of the problem, a pilot survey has been done on 4 apparel manufacturing units located in Agra. The results are presented at the end of this document.

In this phase of the research, these schematic steps will be followed:


Exploratory phase
Explore waste minimization practices in textile and apparel Industry
Preparation of tool
Through literature review
By surveying apparel manufacturing units and export houses
Interview schedule to collect information about apparel and textile waste generation and techniques incorporated to reduce it

3.1.1 Preparation of tools to collect data

A self constructed Questionnaire will be prepared to collect information regarding the quality and quantity of waste generation in textiles and apparel industries. This questionnaire will be prepared for the administrators in top management in the industry. The questionnaire will be designed to analyse the following: the waste types generated (type of fabric, fibre content), waste packing practices, the waste disposal behaviours of manufacturers, waste disposal cost, barriers for waste management, and the attitude towards waste minimization techniques for preserving the environment. Structured, multiple-choice questions will be constructed. A pilot test will be conducted to ensure the clarity of the questionnaire.

3.1.2 Sample size

The sample size will include 20 apparel manufacturers in Uttar Pradesh India. This sample selection will be based on convenience sampling technique.

3.1.3 Criteria of sample selection

a. The Apparel manufacturing industries should be export oriented.

b. The industries should be located in Uttar Pradesh only.

c. The annual turn-over of textile and apparel industries should be at least 1 crore.

The information collected would thus, facilitate in identifying the different stages and sources of textile waste generation of Indian apparel industry.

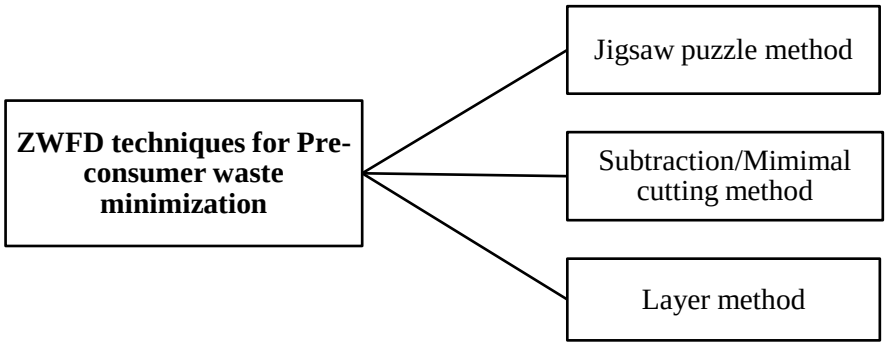
3.2 Phase II- Experimental Phase

In this phase, various waste minimization techniques would be suggested to utilize the pre and post consumer textile and fashion waste. The following work will be carried out in this phase of the research:

Experimental phase
Designing contemporary Indian women wear by incorporating selected techniques of zero waste fashion design through CAD
Pre-consumer zero waste fashion design
Up cycling the post-consumer textile waste by creating potential apparel products.
Post consumer zero waste fashion design

3.2.1 Designing of Indian women-wear by incorporating Pre–consumer Zero waste fashion

The researcher will select any three Pre-consumer waste minimization techniques of ZWFD and construct three different women outfits from each selected method.



Total 15 apparels will be designed and constructed using the above techniques (5 apparels with each technique) in the following stages:

3.2.1.1 Pattern making using CAD

The researcher will use CAD (Computer Aided Design) to make patterns for women wear which will incorporate minimum wastage of fabric. While making patterns, the researcher will include the suggestions of Clothing and Textiles experts that will help for improving designs further.

3.2.1.2 Fabric selection for clothing

To develop women wear that will reduce the wastage of fabric, the researcher will select the fabric for Pre-consumer Zero waste fashion design keeping in the mind the needs, style and prevalent fashion.

3.2.1.3 Fabrication of apparels

In this stage, on the basis of the patterns created and evaluated for the effectiveness of zero waste fashion design, the researcher will construct the contemporary Indian women attire that will represent the use of minimum wastage of clothing.

The fabrication will be done in the following stages:

Stage I –Cutting

The created patterns will be placed on these fabrics for cutting. While cutting the fabric and used and discarded clothing the researcher will keep in mind the concept of minimum or zero waste.

Stage II- Stitching

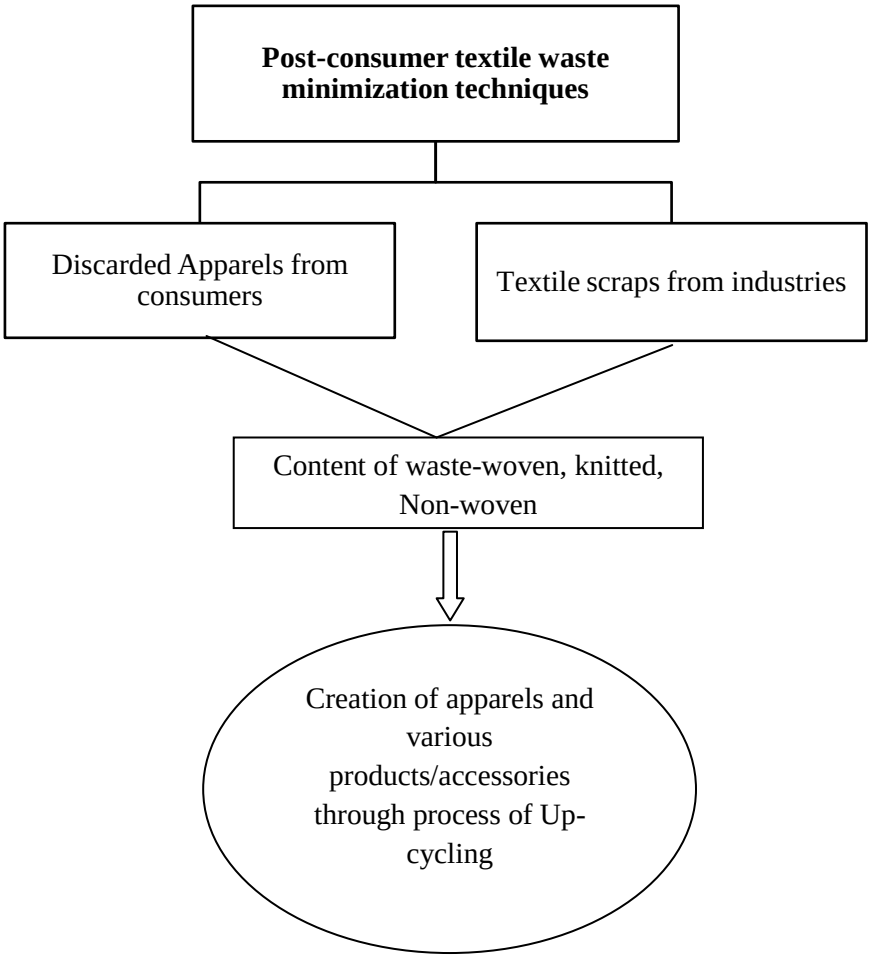
After cutting the fabric, the researcher will construct these outfits. These outfits will be stitched using appropriate seams, finishes, fasteners and other accessories and products will be made using the left over fabric, if any.

Stage III- Adornment

After stitching the outfits, the researcher will use different trimmings and fasteners such as Button, Buckle, Embroidery, Frills, Lacing, and Velcro etc. for making these outfits attractive and elegant.

3.2.2 Designing of Apparel Products by incorporating Post-consumer Zero waste fashion design technique of Up-cycling

The researcher will use old and discarded clothing, leather waste and non-woven to create various new value added Apparel products.


Post-consumer textile waste minimization techniques
Discarded Apparels from consumers
Textile scraps from industries
Content of waste-woven, knitted, Non-woven
Creation of apparels and various products/accessories through process of Up-cycling

3.2.2.1 Collection of Textile and Apparel waste

Hence, this study has planned to minimize textile and apparel waste, efforts would be made to utilize post-consumer waste through a novel technique of up-cycling. The textile waste from industries in form of scraps would be collected by the researcher at the time of conducting the survey. Discarded clothing would be collected from consumers as Apparel waste and would be used design and create new apparel products to make it sustainable. This used clothing would collected by placing donation bins at relevant locations.

The content waste collected would comprise of Woven, Knitted, Leather and Non-woven waste. Thus, efforts would be made to utilize both pre and post consumer fashion wastes through various techniques of up-cycling.

3.3 Phase III- Evaluation

3.3.1 Preparation of assessment schedule for evaluation of designed apparels and product

To assess the acceptability and suitability of created contemporary Indian women wear and apparel products the researcher will develop a five point rating scale. Rating scale will be prepared to evaluate acceptability and suitability of women wear, created through Zero waste designing and Up-cycling process.

The questionnaire will also include rating of constructional and aesthetic features like comfort, quality of stitching, design, color-combination and fabric type etc. An effort would also be made to know the attitudes of respondents towards zero waste and up-cycling process.

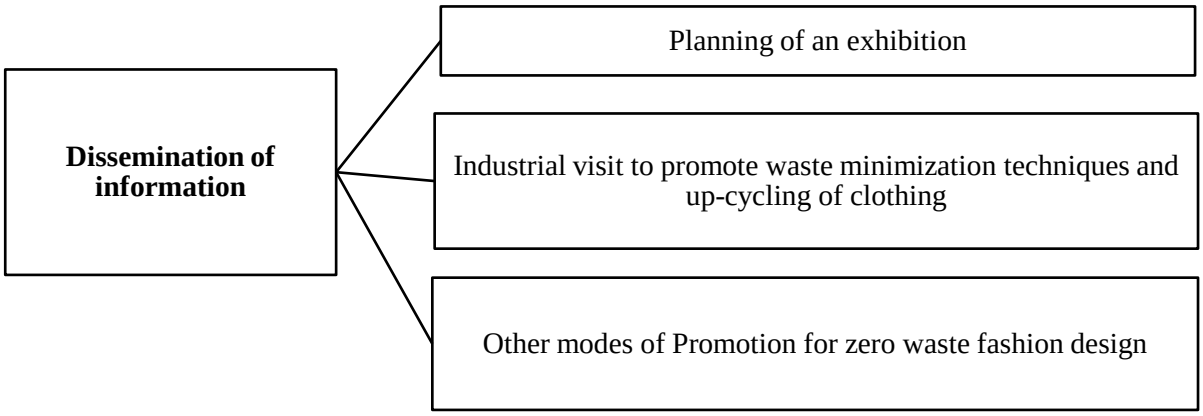
3.3.2 Statistical analysis

This data will be tabulated and analyzed with the appropriate statistical techniques. The following statistical technique will be applied to analyze data.

- Percentage
- Weighted mean
- Other statistical techniques could be incorporated later depending on the type of data collected.

3.4 Phase IV –Dissemination of Information

The process of research is incomplete if the exploration and experimentation techniques carried out for textile and fabric waste minimization does not reach its stake holders, viz. the apparel manufacturing industries, research institutes and training centers etc. Therefore, this last phase dealt with the dissemination of information to promote waste minimization and Up-cycling techniques. Following steps will be followed by the researcher in this phase.


Dissemination of information
Planning of an exhibition
Industrial visit to promote waste minimization techniques and up-cycling of clothing
Other modes of Promotion for zero waste fashion design

3.4.1 Planning of an exhibition

To generate awareness regarding minimization the wastage of fabric and Up-cycling of clothing the researcher will play an exhibition to promote these techniques. The deigned apparels and related products will be displayed in this exhibition to increase the usage of waste minimization techniques and Up-cycling of clothing.

3.4.2 Industrial visit to promote waste minimization techniques and Up-cycling of clothing

The researcher will visit to the industries and demonstrate the created contemporary Indian women wear and apparel products using waste minimization and up-cycling techniques. This would be a small effort to disseminate and promote the adaptation of these techniques by the industries to save environment from pollution and to make clothing sustainable.

3.4.3. Other modes of Promotion for zero waste fashion design

The researcher will promote zero waste fashion designing by creating web portal, designing and distributing pamphlets among consumers for creating awareness regarding effects of apparel wastes among consumers and the benefits of zero waste fashion design and Up-cycling techniques.

Appendix 1

In order to have a general overview of the waste generated in the apparel manufacturing industries and to explore the stages and sources of apparel wastes, a pilot study was carried out in four apparel manufacturing units Trela Tex, Bedi and Sons, Neeraj Textiles and Kishore Exports located in Agra.

A self made questionnaire was used to survey four apparel manufacturing units by the researcher. The questionnaire was incorporated with some factors such as: quantity of produced apparel waste, attitude of manufacturer regarding apparel wastes, types of wastes, ways to reduce wastes, ways to dispose wastes and discarded clothing, reasons of producing wastes and acceptance about adopting some creative solutions to minimize wastes etc. The following results were obtained by the researcher:

- Per day approximately 5 kg. waste is produced in each apparel industry.
- Cutting stage of garments produces a large quantity of wastes.
- Two industries dealt with recycling of apparel wastes and whereas few disposed wastes in garbage.
- All industries showed interest to adopt fabric waste minimization techniques to reduce apparel and textile wastes..
- All manufacturers were ready to adopt solutions to minimize wastes.

  The additional information explored by the researcher during the pilot study has been shown in the table in Appendix 1.

Appendix-I

Pilot-study report

S. No.	Name of Apparel manufacturing unit	Type of Market	Manufactured apparel product	Sources of designs	Type of waste produced	Quantity of apparel wastes produced	Best way to reduce apparel wastes	Working with issue of Up-cycling of apparel wastes	Disposal techniques of apparel wastes	Working with Recycling of apparel wastes	Attitude of manufacturers regarding apparel wastes	Acceptance for solutions of minimize apparel wastes	Solutions for discarded clothing
1.	**Trela Tex**	Domestic	Kid's wear	Self designed & buyer's choice	Woven	Approx. 1 kg per day	At pattern layout	For making quilts at Fatehpur-Sikri	Up-cycling	No	Neutral	Yes	Sell out to other manufacturers
2.	**Neeraj textiles**	Domestic	Men's wear	From catalogue	Woven	Approx. 5-6 kg per day	Using specific techniques	No	Garbage	No	Positive	Yes	Garbage
3.	**Bedi and sons**	Domestic	Men's wear	Media, self designed & buyer's choice	Woven	Approx. 2-3 kg per day	Using specific techniques	No	Garbage	No	Positive	Yes	Donate /Garbage
4.	**Kishore exports**	Domestic	Men's wear, women's wear	Self designed & buyer's choice	Woven and knitted	Approx. 5-6 kg per day	At pattern layout	Selling out wastes at Fatehpur-Sikri	Up-cycling	No	Positive	Yes	Up-cycle in to other item

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